ONBOARD HIGH RATE/CAPACITY DATA SYSTEM

ENHANCED TEST BED

PERFORMANCE REQUIREMENTS

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PREFACE

The Civilian Space Technology Initiative (CSTI) High Rate/Capacity Data Systems Program, under Data Systems Technology Working Group (DSTWG) management, sponsors the development of high performance architectures, processors, storage, and system technologies needed to support complex high data rate science instruments for flight applications in the next decade. The Configurable High Rate Processing System (CHRPS) is part of this program. Its goal is to develop an onboard system with very high rate data processing and storage capability in order to alleviate the problems of sending large amounts of data to the ground, via a limited downlink resource. CHRPS will be adaptable to different instruments and missions by reconfiguring in real time to support various experiments.

CHRPS consists of various processors, storage, and other Engineering Development Modules (EDMs) connected via the CHRPS Network. The EDMs are being developed by various NASA Centers. GSFC Code 735 is responsible for developing an Enhanced Test Bed (ETB) that will provide testing and validation for NASA's high data rate and high data capacity program's EDMs.

Among the EDMs being developed are: a Spaceflight Optical Disk Recorder (SODR) by Langley Research Center (LaRC), general-purpose processors including an Imaging Spectrometer FLight Processor (ISFLIP), GSFC's pipeline processor, a future Synthetic Aperture Radar Processor (SARP) and Advanced Imaging Processors (AIPs) by the Jet Propulsion Laboratory (JPL), and JPL's MAX/COSMOS and LaRC's VMP/COSMOS multiprocessors. A Common Spaceborne Multiprocessor Operating System (COSMOS) is the operating system and will be composed of a Graph Management Operating System (GMOS) from LaRC and HYPHOS from JPL. MAX/HYPHOS is JPL's multiprocessing hardware/software system architecture. JPL is also working on technology development for storage and processors. Ames Research Center (ARC) is working on technology development such as symbolic processors and neural chips; and, heterogeneous systems architectures. LaRC is also working on technology development for networks, including a Multipurpose Fiber Optic Transceiver (MFOX). GSFC's CHRPS Network EDM will provide the connectivity for the other EDMs. GSFC is also working on lossy and lossless compressors using various algorithms such as Rice's and Discreate Cosine Transform (DCT), as well as a GaAs-based processor. GSFC is providing the ETB facility.

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ONBOARD HIGH RATE/CAPACITY DATA SYSTEM
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1. INTRODUCTION

1.1 PURPOSE

The purpose of this document is to describe the Onboard High Rate/Capacity Data System Enhanced Test Bed (ETB) performance requirements.

1.2 SCOPE

The ETB performance requirements are given. They will be used as input to trade studies and design efforts to implement the ETB from which the specifications will result.

Only primary performance requirements are given. For example, the required error rate on the fiber optics link will be stated; however, allocation of losses to fibers, connectors, switches, etc., which may contribute to the error rate, will be part of the design process. Data rates will be given, but the choice of integrated circuit technology will be the result of trade studies considering radiation hardness, cost, speed, etc.

1.3 ORGANIZATION

Section 2 gives an overview of the ETB and identifies the Engineering Development Modules (EDMs) provided in the ETB facility. Capabilities of the EDMs that drive the ETB performance requirements are also summarized in this section.

In Section 3, the Configurable High Rate Processing System (CHRPS) Network EDM, as the backbone connecting all other EDMs, is described so users can understand its capabilities and how it supports attached EDMs. Performance Testing and Validation Resources (PTVR) supporting the ETB are also described.

Section 4 discusses possible evolution of the ETB and EDMs, but is not intended to preclude other improvements which may be possible.

Section 5 consists of appendixes with reference material such as a glossary of acronyms and terms, and lists of documents and standards referenced in the description of the ETB. A suggested method of verifying the ETB is given in a test matrix.

2. OVERVIEW OF THE ENHANCED TEST BED

This section describes the ETB as shown in Figure 2-1. The ETB consists of the CHRPS Network EDM and PTVR. The CHRPS Network provides the backbone connectivity for instruments, high capacity storage, image processors, and other future EDMs.

2.1 PURPOSE OF ETB

The ETB will provide for testing of NASA's onboard high rate and high capacity data handling EDMs to be developed over the next decade, as well as to provide a demonstration and development facility for the CHRPS itself. Developers can test their equipment in the ETB facility and utilize the functionality provided.

The CHRPS concept has been motivated by the trend towards flying more instruments with ever increasing data rates, which will exceed the Tracking and Data Relay Satellite System (TDRSS) downlink capacity of 300 Mbps. Flexible reconfiguration of onboard processing resources will allow instruments to process data on board and result in lessened demands on the limited downlink resources. Reconfiguration will also result in lessened total demand for weight and power.

2.1.1 General Requirements for Flight Qualifiability

The flight requirements to be considered in the CHRPS Network design are summarized in Table 2-1, and are based on a polar orbit mission and the Earth Observing System (EOS) General Instrument Interface Specification (GIIS) requirements document.

2.2 DESCRIPTION OF THE EDMs

A description of each EDM in the ETB facility is given. The performance requirements of the CHRPS Network EDM, which the other EDMs connect to, are presented in Section 3.

2.2.1 Configurable High Rate Processing System Network

The CHRPS Network is shown in Figure 2-2. The CHRPS Network consists of:

a. A high rate network for science data made up of an optical switch and a high rate interface connected by fiber optic cabling

b. A low rate network for control and status

c. A CHRP System Controller Application (CSCA) executing in a dedicated computer, and short-term plan (STP) that contains data fields for scenarios, operations, and time-tagged commands

d. A gateway to TDRSS

e. A gateway to a spacecraft Local Area Network (LAN) or data bus

2.2.1.1 High Rate Network—The high rate network consists of an all optical, crossbar (nonblocking) switch that provides high-speed paths for science data transmissions.

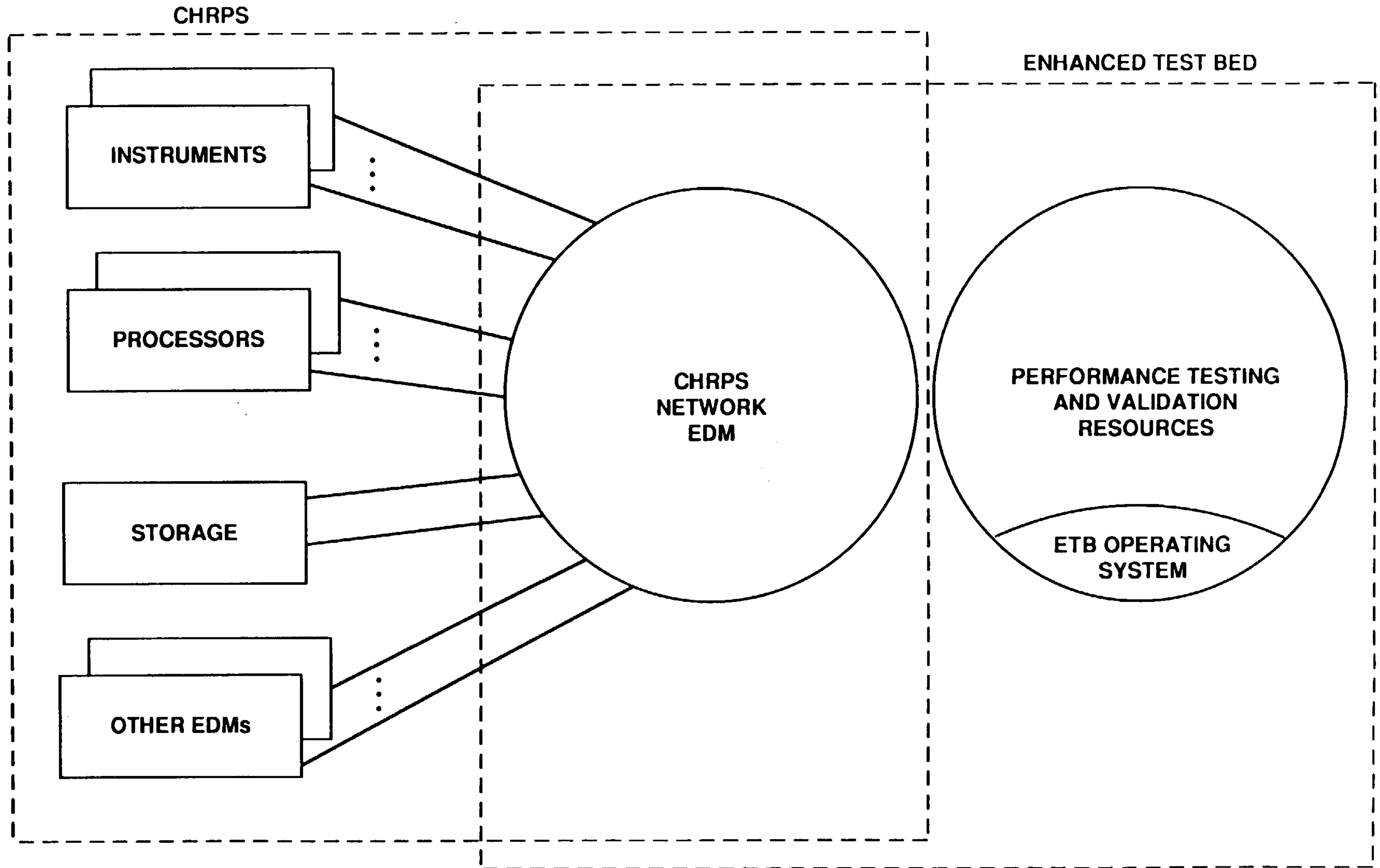

Figure 2-1. CHRPS and ETB Relationship

Table 2-1
Summary of Flight Requirements

Summary of Flight Requirements to be Considered in the CHRPS Design
(Including ground storage, testing, and launch to orbit)

Note: Actual requirements will depend on the specific flight program using the CHRPS.

Radiation

EDMs must be designed for a 100 krad total dose at the component level. This value will depend on the lifetime and the amount of shielding provided.

Note: Radiation dosage is very dependent on the location of the electronics on the spaceborne platform as well as the orbit.

Temperature

EDMs must operate in a temperature range from -25 to 50 degrees C with transients of ±10 degrees C per hour.

Humidity

EDMs must work from 1 to 100% humidity in salt air atmosphere.

Vacuum

EDMs must be able to function from 813 torr to 1 x 10E-10 torr.

Vibration and shock

The EDMs must be designed so that they can tolerate normal shuttle vibration, or other launch vehicle such as Atlas or Scout, after being packaged and tested for flight.

Electromagnetic Compatibility

The EDMs must not produce more than 0.1 gauss and must not have a dipole moment of more than 0.1 amp-meter^2. They must be able to operate in juxtaposition with payloads and experiments and be able to tolerate a 10 gauss transient field and 0.5 gauss ambient condition.

Table 2-1 (Continued)

Physical

Size, weight, and power are mission specific but must be minimized. No specific allocation can be made to the CHRPS Network or other EDMs, as this will depend on the specific flight program that uses these devices, but these resources are always scarce, and the design must use these as key drivers.

Reliability

Is mission dependent. CHRPS may need to operate 15 years without failure. It must operate after one failure and fail soft after additional failures.

Contamination

The materials used must not cause contamination by outgassing.

Safety

The EDMs must be safe. The requirements are mission specific. There must be no explosion hazard or noxious fumes. The EDMs must not be flammable. Instruments using pyrotechnics must be reviewed by the program for safety.

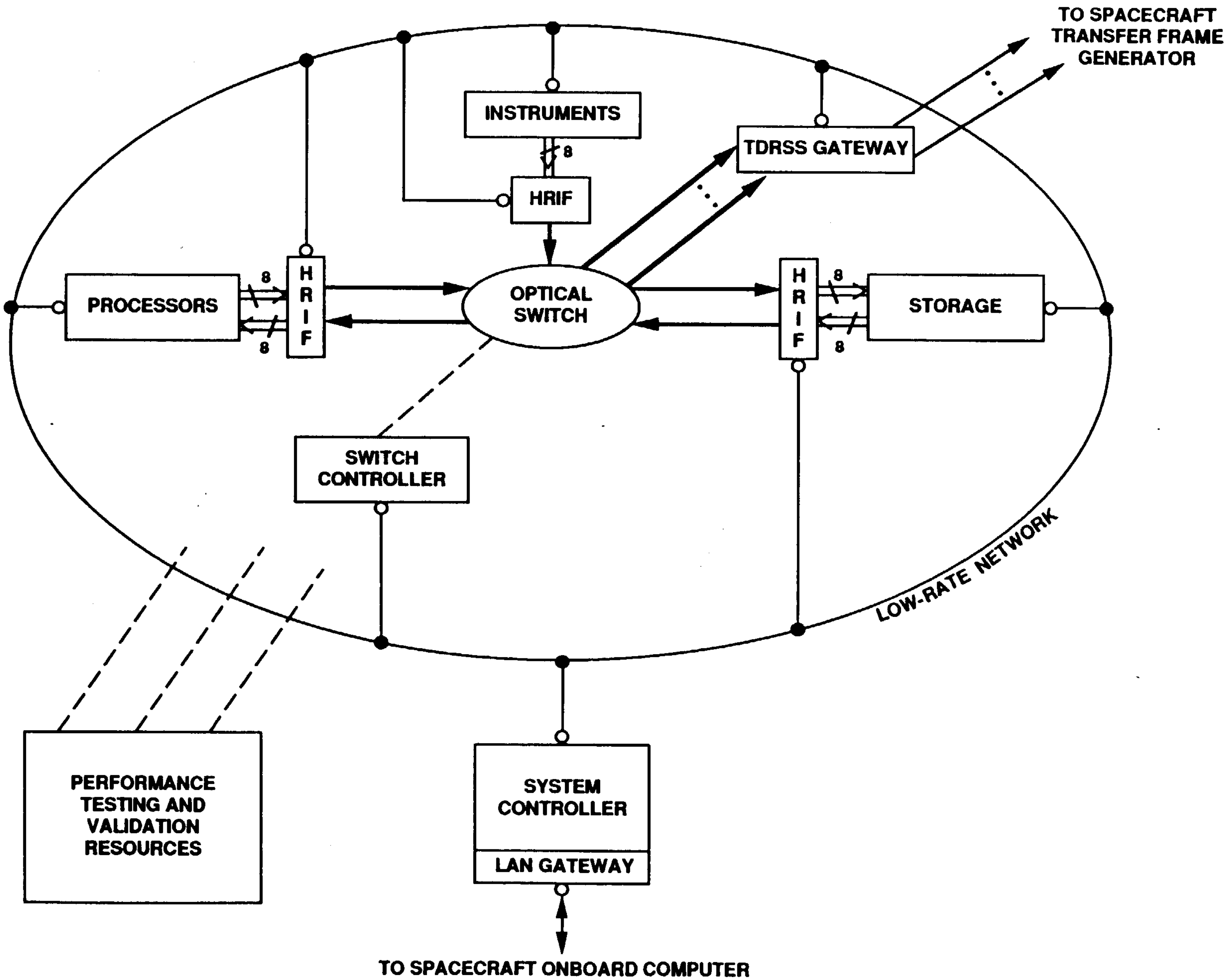

Figure 2-2. CHRPS' and ETB

EDMs connect to the CHRPS Network by way of a High Rate Interface (HRIF). This interface provides electrical to optical and optical to electrical conversions.

The CHRPS Network is transparent to the data. It is expected that users of the CHRPS Network, however, will use Consultative Committee on Space Data Systems (CCSDS) packets when communicating with other EDMs, so as to avoid the problem of developing and testing new protocols, which each user would have to undertake. Considering the speeds and length of scientific data streams, retransmission on board is not practical. Forward error correction, if needed on board, must be provided by user's equipment. Retransmissions to the ground will be handled by the Transfer Frame Generator (TFG).

It is anticipated that ultimately the HRIF will be incorporated into flight modules.

2.2.1.2 System Controller—CHRPS is controlled by a software application, the CSCA, that controls the operations of the ETB according to an STP. This system controller function is written in the high-level Ada language and resides in an ETB computer dedicated to the CHRPS Network operations.

The STP is a plan composed of the steps for a processing scenario to be executed in the ETB facility. The system controller converts the STP into a command sequence and distributes the commands contained to the EDMs over the low rate network. Some of these commands will direct the CHRPS Network to make connections between the various EDMs, while some direct the storage or the various processors.

2.2.1.3 Low Rate Network—A low rate network is provided for command distribution and status response collection. All EDMs will connect to this low rate network to receive commands to be executed and to give status replies.

2.2.1.4 TDRSS Gateway—A TDRSS gateway connection to a communications subsystem will be provided. It will have multiple data inputs at different rates and will produce a continuous bit stream of data at a fixed data rate to the spacecraft (S/C) modulator. This data stream will be formatted using CCSDS packets in a Multiplexing Protocol Data Unit (M_PDU).

2.2.1.5 LAN Gateway—A gateway to a LAN will provide a connection to the EOS Command and Data Handling (C&DH) test bed that will simulate a spacecraft data bus and space-ground links for the ETB.

2.2.2 Instruments

The ETB will be capable of supporting scientists' high data rate imaging instruments such as High Resolution Imaging Spectrometer (HIRIS), Moderate Resolution Imaging Spectrometer (MODIS), Synthetic Aperture Radar (SAR), and ASTER.

2.2.3 Processors

Various types of processors will be included in the ETB facility as they become available. Functions such as data compression, information extraction, vector processing, corner turning, etc., will be performed by these processor EDMs.

Processors and instruments can send data to each other as well as other EDMs through the CHRPS Network at actual throughput data rates up to 800 (TBR) Mbps.

2.2.4 Storage

The storage EDM is the Spaceflight Optical Disk Recorder (SODR) that is a high capacity storage device using multiple optical disks and input/output (I/O) ports to achieve both high volume storage and high data rates.

SODR, using HRIFs directed by the system controller, provide flow control and rate buffering capability between EDMs such as an instrument and a processor.

SODR will use multiple I/O ports so as to serve multiple EDMs simultaneously. The actual operating speed will be on the order of 1 Gbps to allow for overhead due to coding and protocols.

A total storage of at least 80 Gbytes (640 Gbits) will be provided by the later stages of ETB use. Initially, at least 20 Gbytes (160 Gbits) will be provided.

2.2.5 Other EDMs

Other EDMs will be attached in the ETB facility as they become available.

2.3 PERFORMANCE TESTING AND VALIDATION RESOURCES

In addition to the EDMs, PTVR will be attached to the ETB in order to verify that data are being sent and processed correctly, and to verify the error rates of the transmissions. Test equipment simulating the TDRSS link so as to check the data being sent to the communications subsystem is also provided. This will be useful to assess the effect of transmission errors on the final data product.

The state of the network and the testing being performed will be graphically displayed. An ETB Operating System (ETBOS) will assist in automating the testing and monitoring operations, including keeping the status displays current.

Figure 2-3 illustrates the ETB and PTVR.

Performance Testing and Validation is described in more detail in Section 3.7.

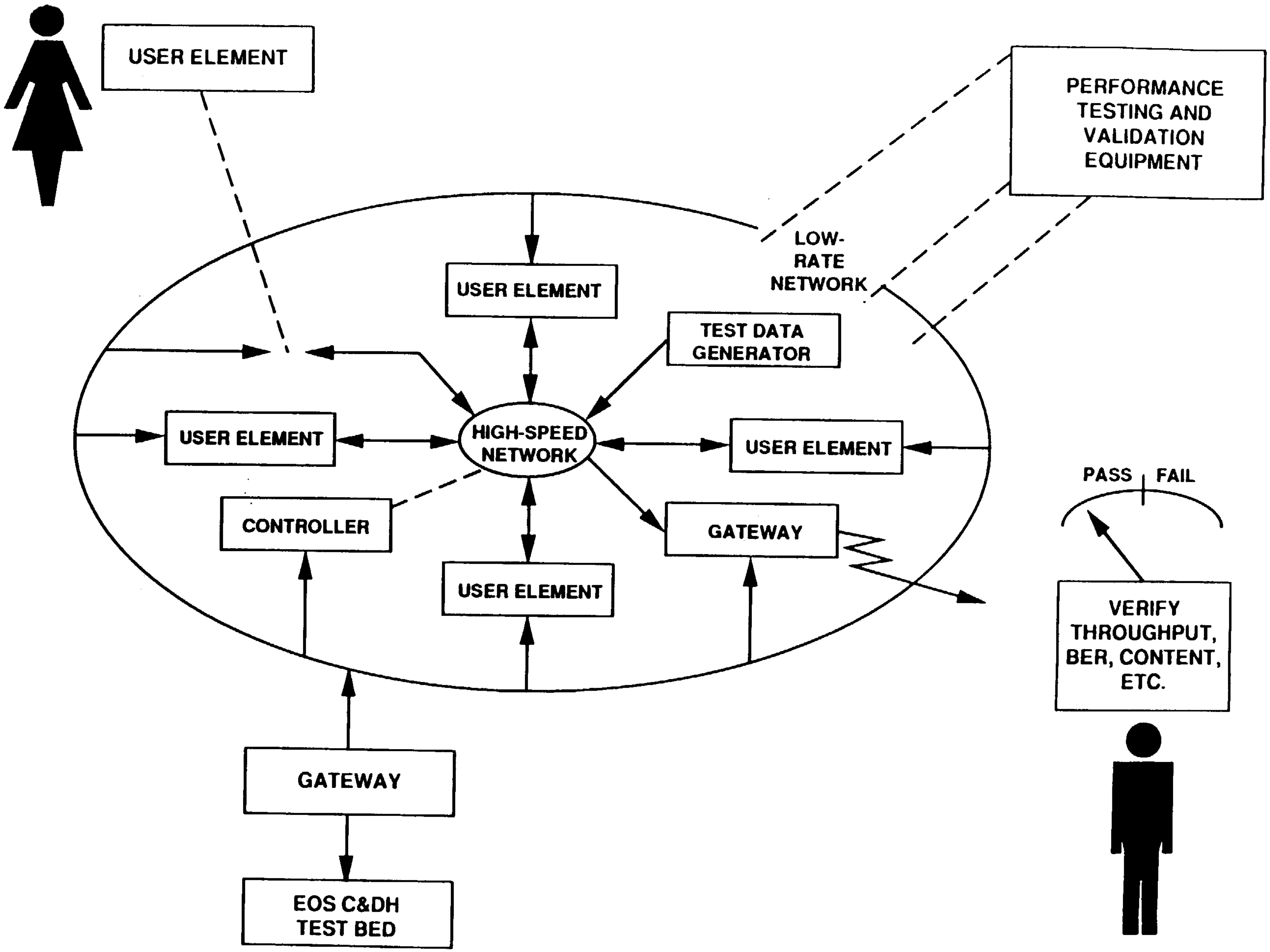

Figure 2-3. Enhanced Test Bed Verification

3. PERFORMANCE REQUIREMENTS OF THE CHRPS NETWORK EDM

The CHRPS Network provides the resources required to process, temporarily store, and condition the data to be transmitted to the ground.

The CHRPS Network hardware and software performance requirements are given below. Other EDMs are physically connected to the CHRPS Network by way of an HRIF and the low rate network. Details of other EDMs shall be provided in their own documentation.

3.1 HIGH RATE NETWORK GENERAL REQUIREMENTS

The network error rate for the CHRPS Network, including the optical switch, fiber optics, and the HRIF, must be better than the aggregate user error rate of 10E-12.

The network must support a distance of up to 50 meters between the HRIF and the optical switch.

3.2 OPTICAL SWITCH

The high rate network data paths are implemented by an optical switch and fiber optics. The switch shall be an all-optical crossbar (nonblocking) switch that provides high-speed paths for science data.

To meet the anticipated number of ports for instruments, storage, TDRSS gateway, and processors, the switch shall, by the end of the ETB operational timeframe, be capable of at least 32 by 32 input and output connections. This is based on allocating six ports to the SODR, four ports to the TDRSS gateway, six ports to processors, eight ports to instruments, and eight ports for future EDMs and/or PTVR equipment use.

The optical switch shall receive commands over the low rate network, which shall direct it to establish connections between the input and output ports of the EDMs. Any combination of input and output ports can be connected simultaneously. One data source is allowed to broadcast data to multiple input ports simultaneously. The switch shall be able to be completely reconfigured in under 100 msec.

Each data path is capable of simultaneously handling a transmission rate of 1 Gbit/sec, so that the net data throughput, including overhead, shall be 800 Mbit/sec (TBR) per path. This is based on an extrapolation of current instrument rates. Coding, such as 4B/5B, will be determined as part of the design process.

3.3 HIGH RATE INTERFACE

Each HRIF connects the user EDMs to a data path capable of handling a transmission rate of 1 Gbit/sec, so that allowing for overhead, the net data throughput shall be 800 Mbit/sec (TBR). HRIFs shall support any lower data rate used by the other EDMs.

The HRIF is insensitive to the data's bit patterns. The design is expected to require buffers that may limit the maximum data packet. However, it shall support CCSDS M_PDU packets of any length up to 882 (TBR) Bytes, at any rate up to its maximum capability.

The HRIF, when development is finished, shall be small enough so that it can be embedded in other EDMs. The exact size will depend on the EDM design and implementation.

3.4 SYSTEM CONTROLLER

The CSCA shall reside in a CHRPS Network computer. The computer shall be a standard 1750A Generic VHSIC Spaceborne Computer (GVSC). [Refer to MIL-STD-1750A in Appendix B for the specifications of the 1750A, and NTIS 91 N 17277 for the GVSC.] The software shall be implemented in Ada. The CSCA shall receive the STP from a simulated spacecraft LAN or data bus. The EOS C&DH test bed shall simulate the spacecraft and its communications link to the ground in addition to the spacecraft LAN. The STP shall contain data fields for scenarios, operations, and commands. Time-tagged commands from the STP shall be loaded into EDMs and the optical switch, where they shall be executed when required. Similarly, software may be sent from the ground for execution in an EDM.

3.5 LOW RATE NETWORK

A low-speed network shall be provided for issuing commands and receiving status. The low rate network must support up to 31 nodes.

In the ETB, the low rate network will be implemented with MIL-STD-1553B, which is capable of a throughput on the order of a few hundred kilobits per second.

3.6 LAN GATEWAY

A LAN gateway capable of connecting to the spacecraft data bus as simulated by the EOS C&DH test bed, shall be provided to transfer the STP from the simulated TDRSS link to the CSCA in the system controller's computer.

3.7 TDRSS GATEWAY

The TDRSS gateway shall have four input ports running at variable rates from the optical switch and be capable of five output lines running at fixed rates of up to 60 Mbps with an aggregate of up to 300 Mbps output.

The TDRSS gateway shall connect to the HRIF and to the TFG according to their interface connections. It shall take the data streams from the input ports at the various rates and deliver it in a format acceptable to the TFG over the five lines at fixed rates. The TFG shall provide fill as required.

3.8 PERFORMANCE TESTING AND VALIDATION RESOURCES

PTVR shall measure Bit Error Rate (BER) performance, bus traffic, and data rates.

PTVR will be used to assist in verifying that EDMs and the ETB facility are operating properly. Key to this verification process is ensuring that the CHRPS Network is properly providing the connectivity and that the system controller is sending appropriate and timely commands to the other EDMs. PTVR will also verify the data being sent to and from other EDMs before and after transmission and/or processing.

The EOS C&DH test bed shall be used to simulate the spacecraft connection to the ETB and CHRPS. The STP shall be initiated on the EOS C&DH test bed and transferred to the ETB system controller application's computer via the LAN gateway and the low rate network provided for command and control use.

An ETBOS will assist in automating the testing being performed, including maintaining the status displays.

Monitoring equipment will assist the operators in the ETB facility by displaying what EDMs and connections are active, the amounts of data being transmitted, the error rates, and the commands being executed by the EDMs. These will all be automatically displayed on monitors attached to PTVR equipment. The inherent error rates of the transmission medium and the optical switch shall be monitored with a commercial BER tester. An adapter to this equipment shall be built as part of the ETB development. Possible PTVR equipment connections verifying the optical paths is shown in Figure 3-1. A possible BER verification connection is shown in Figure 3-2.

A Source Encoder Multiplexer Packetizer (SEMP), shown in Figure 3-3, shall simulate an onboard high rate imaging instrument, and provide data for testing purposes as part of the test equipment resources available.

Additional verification capability will be available as appropriate to the EDMs being tested and the STP being executed. Original and processed data shall be compared when data compression techniques are employed. Imaging data can be displayed before and after processing, and/or storage EDMs have handled the data. Visual displays can also indicate the correct operations of the EDMs. Figure 3-2 also shows a possible test setup for comparison of imaging data. Other data can be compared by examining the bits before and after storage and/or processing. Data being transmitted through the CHRPS Network can be simultaneously sampled at the sender and receiver by means of a logic analyzer that will provide capability for analysis and comparison of received data to the data originally sent. An adapter tapping onto an EDM's HRIF input lines can capture the data actually sent. A possible PTVR arrangement for verification of the data sent to the communications link is shown in Figure 3-4.

Figure 3-5 shows typical displays that will be available to assist the users of the ETB facility. The first display shown indicates which connections have been activated by commands to the optical switch. The second display presents the amount of data traffic being handled on selected links versus a selected time-interval scale. The third display indicates recent commands that have been executed, and upcoming commands which are about to be executed. The final display indicates the quality of all links by giving the cumulative BER from a selected point in time for each possible path through the CHRPS Network. Out-of-tolerance results, i.e., those exceeding 10E-12 BER, will be highlighted in red. Zero results will be shown in green, and error rates better than the 10E-12 will be highlighted in yellow.

Other displays, as indicated is Figure 3-2, can show image data before and after processing or handling for a visual check on the effects of compression or other processing.

Data sent and received can be compared bit by bit, and displayed on the system controller's display, in order to verify that it has been properly generated and received.

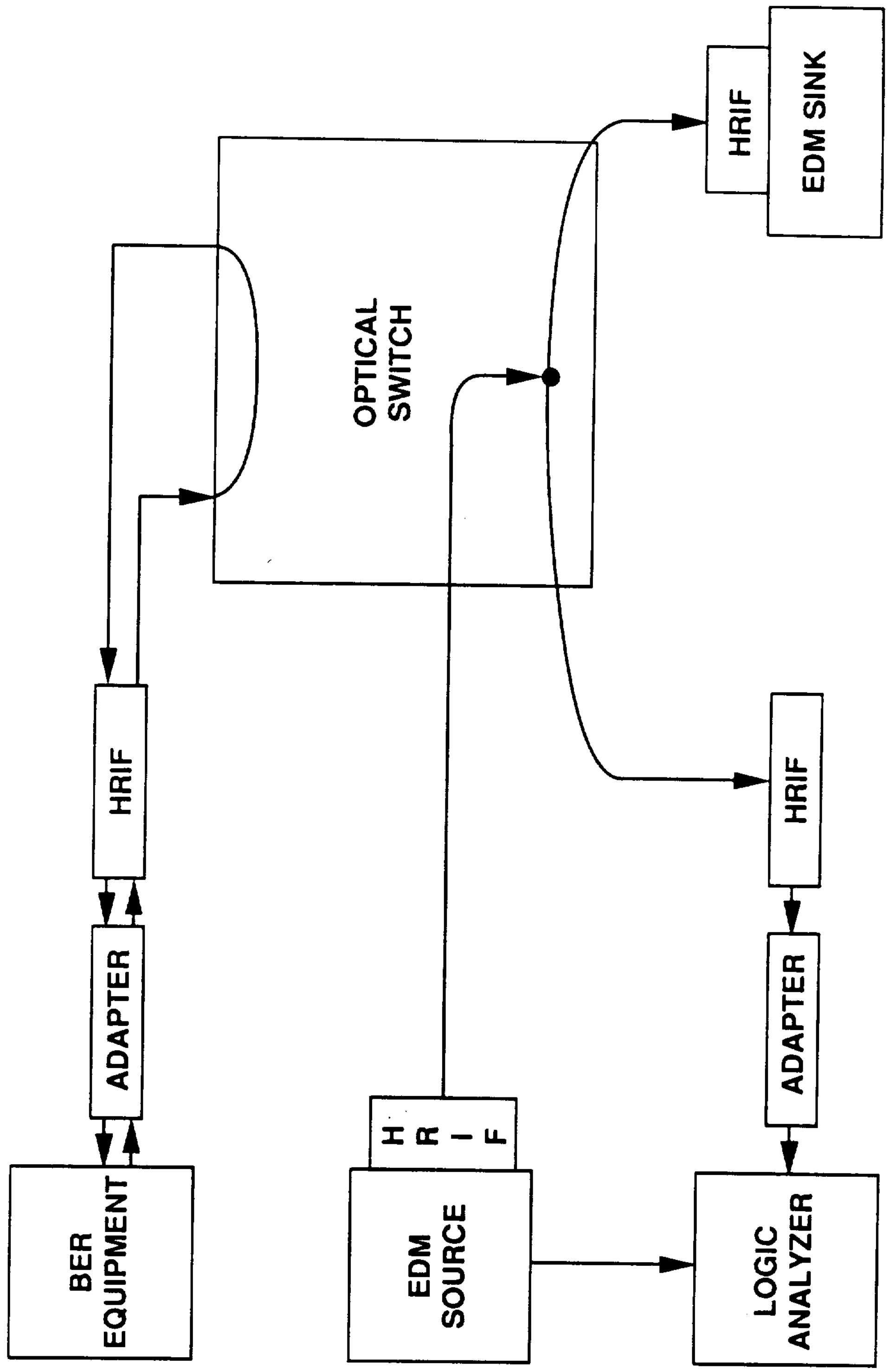

Figure 3-1. Optical Verification

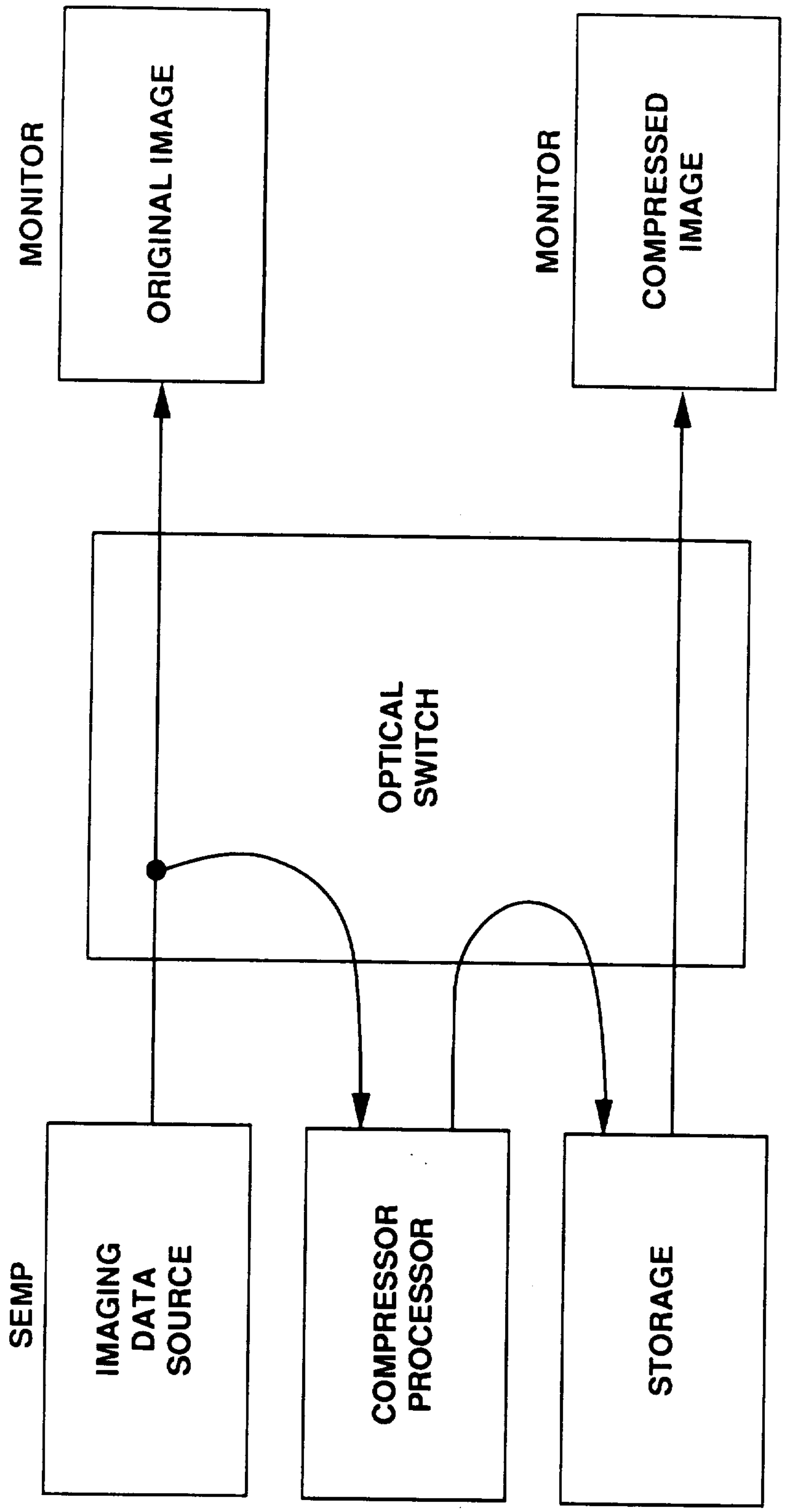

Figure 3-2. Imaging and Data Verification

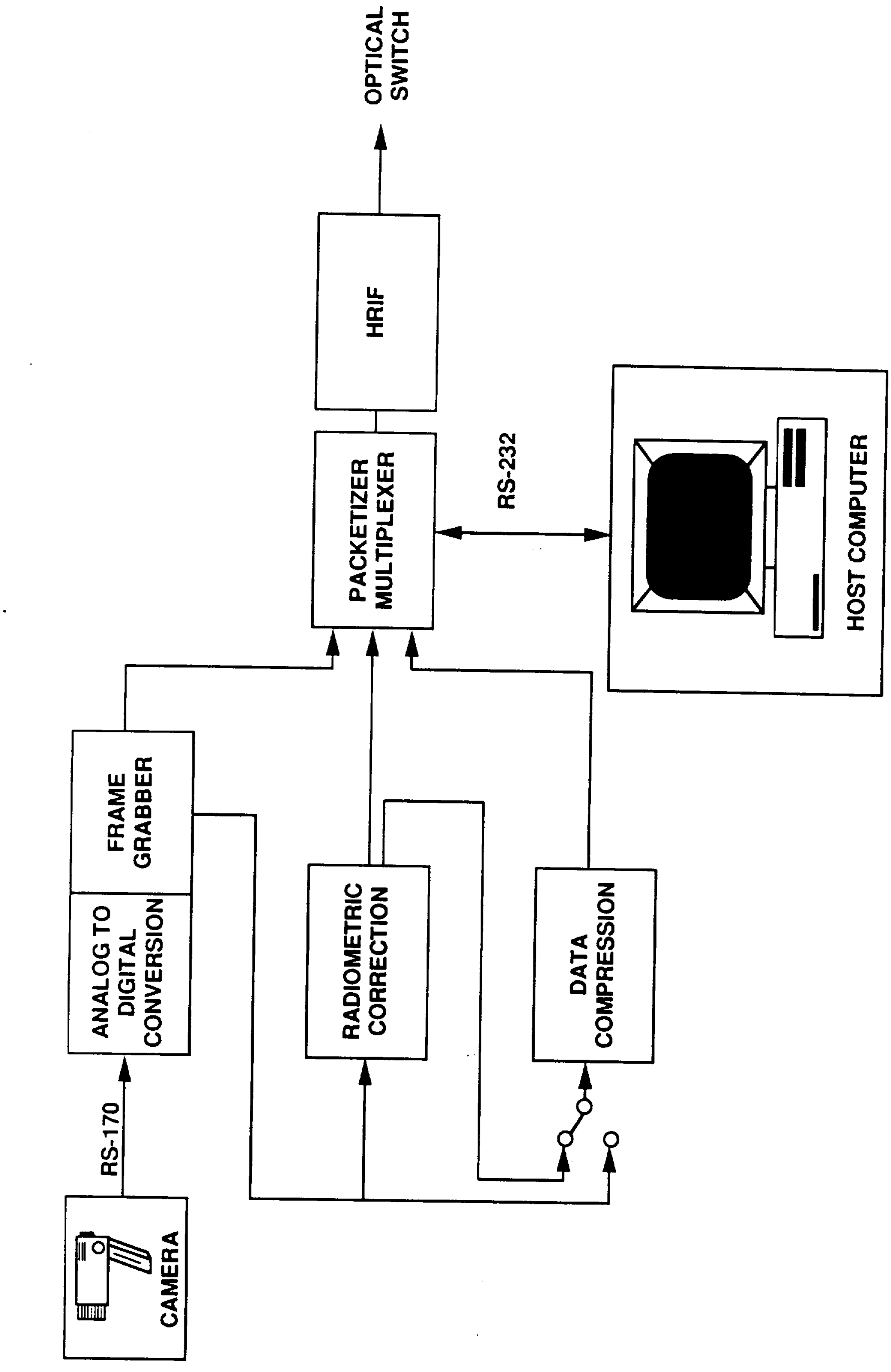

Figure 3-3. Source Encoder/Multiplexer Packetizer System Diagram

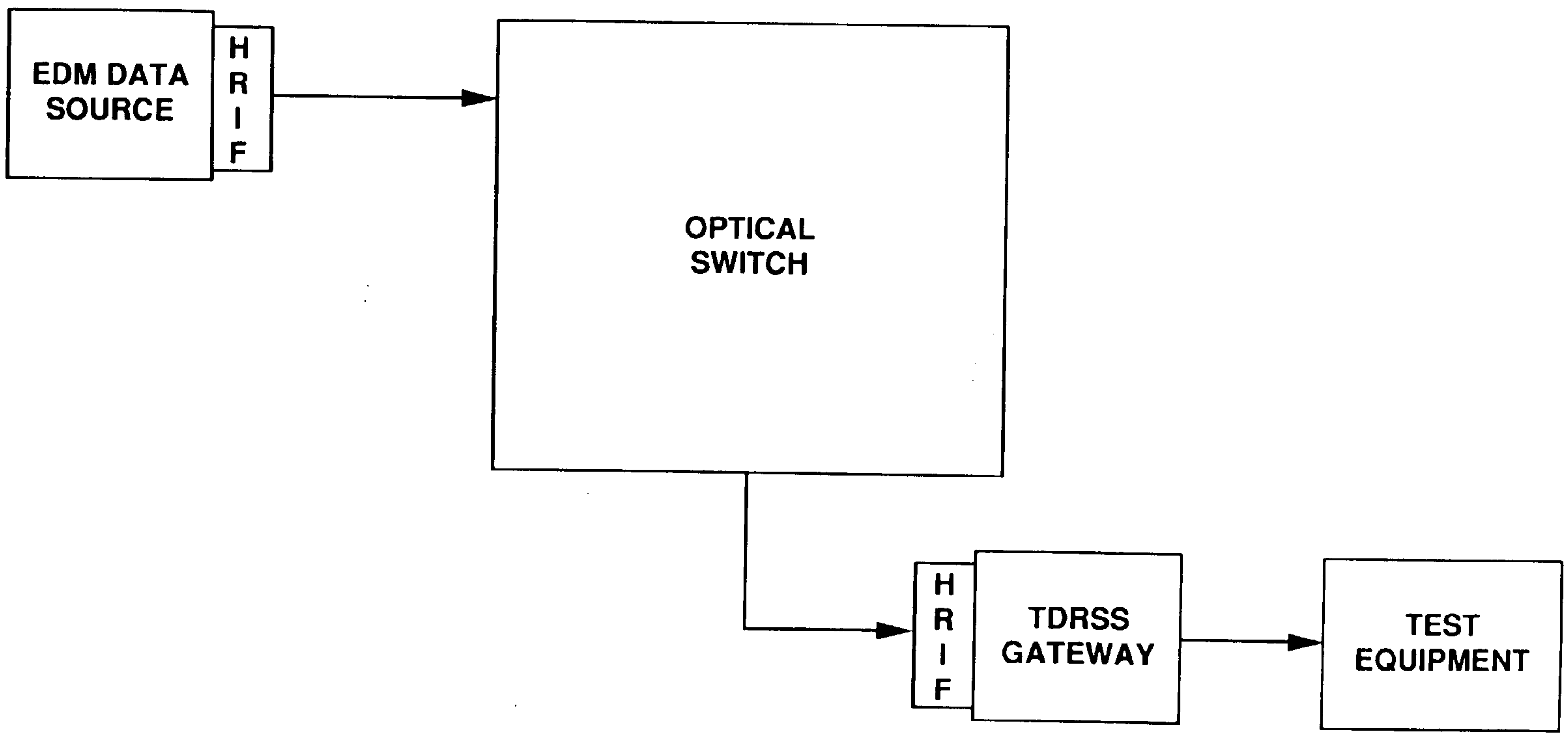

Figure 3-4. TDRSS Gateway Verification

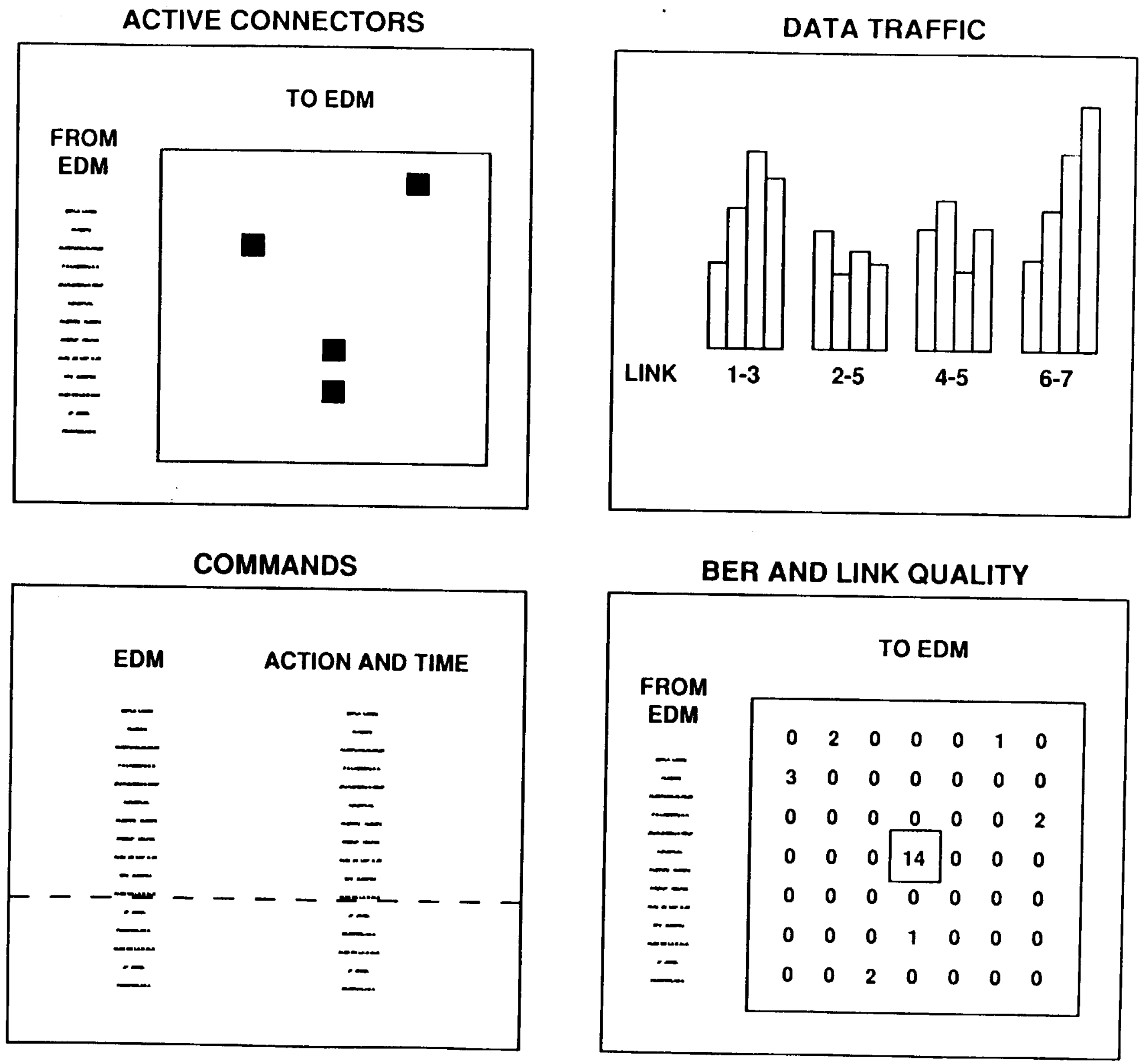

Figure 3-5. PTVR Displays

4. ENHANCED TEST BED EVOLUTION

The ETB will commence development in the 1992 timeframe with a projected operational phase starting from 1995 and running for several years. Over this period of time, it is expected that the designs of the EDMs may evolve to incorporate improvements so as to meet all their requirements by the end of the ETB operational timeframe. In some cases, preliminary or breadboard versions will be provided for other EDMs to use while the ultimate version is still undergoing development.

The total amount of storage is also expected to grow as the technology used is refined.

The optical switch will evolve from the small number of ports (8 by 8) available initially, to a 16 by 16 capability early in the ETB life, and currently is planned to eventually become a 32 by 32 capability as the optical switching technology is improved over the life of the ETB.

If Advanced TDRSS (ATDRSS) comes on line during the life of the ETB, then it may be desirable to replace the TDRSS gateway with one that is capable of running at the faster ATDRSS aggregate data rate, which is anticipated to be a 650 Mbps downlink and a 50 Mbps uplink using Ka-band, in addition to the 300 Mbps on Ku-band as is now available.

If ATDRSS does not come on line as planned for the 1997 timeframe, then alternatives providing faster data rates, such as using Trellis Coded Modulation with the current TDRSS can be investigated.

The HRIF will be developed so as to be small enough to be embedded within the flight modules using it.

For flight use, the ETB components will need to be used in a redundant configuration so as to meet the reliability requirements of flight. The CSCA will be upgraded to monitor and switch to the redundant components as required.

More autonomy will migrate to the onboard system controller with an STP being implemented in a macro type of format. This will allow for possible compression of the command sequences being transmitted as well as using "template" sequences stored on board which only require filling in the "blanks" such as start time, stop time, direction for field of view, etc.

The 1553B bus may evolve to the fiber optic version 1773 bus.

5. APPENDIXES

The following appendixes are included as part of the Functional Specifications of the Enhanced Test Bed document:

Appendix A Glossary of Acronyms and Terms

Appendix B Referenced Documents and Standards

Appendix C Test Matrix

APPENDIX A

GLOSSARY OF ACRONYMS AND TERMS

This appendix lists, in alphabetical order, acronyms and special terminology used in this document.

Ada	DOD Standardized Software Language
AIP	Advanced Imaging Processor
ARC	Ames Research Center
ATDRSS	Advanced TDRSS
BER	Bit Error Rate
BERT	Bit Error Rate Test
Bit	Binary Digit
C&DH	Command and Data Handling
CCSDS	Consultative Committee on Space Data Systems
CHRPS	Configurable High Rate Processing System
CLK	Clock
CMD	Command
CMOS	Complementary Metal Oxide Semiconductor
COSMOS	Common Spaceborne Multiprocessor Operating System
CSCA	CHRP System Controller Application
CSTI	Civil Space Technology Initiative
DCT	Discrete Cosine Transform
DMA	Direct Memory Access
DSTWG	Data Systems Technology Working Group
EDM	Engineering Development Module
EOS	Earth Observing System
ETB	Enhanced Test Bed
ETBOS	ETB Operating System
G	Giga – SI unit for 10E-9
GaAs	Gallium Arsenide
Gbit	Gigabit
Gbit/s	Gigabits per second
GIIS	General Instrument Interface Specification
GMOS	Graph Management Operating System

GSFC	Goddard Space Flight Center
GVSC	Generic VHSIC Spaceborne Computer
HIRIS	High Resolution Imaging Spectrometer
HYPHOS	JPL operating system for MAX
I/O	Input/Output
ISFLIP	Imaging Spectrometer Flight Processor
JPL	Jet Propulsion Laboratory
LAN	Local Area Network
LaRC	Langley Research Center
LeRC	Lewis Research Center
M	Mega - SI prefix for 10E-6
MAX	JPL Multiprocessor system architecture (with HYPHOS)
Mbps	Megabits per second
MFOX	Multipurpose Fiber Optic Transceiver
MIL-STD	Military Standard
Mips	Millions of Instructions per Second
MODIS	Moderate Resolution Imaging Spectrometer
M_PDU	Multiplexing Protocol Data Unit
NASA	National Aeronautics and Space Administration
OBC	Onboard Computer
PTVR	Performance Testing and Validation Resources
RAM	Random Access Memory
ROM	Read Only Memory
RTOP	Research and Technology Objectives and Plans
RX	Receiver

S/C	Spacecraft
SAR	Synthetic Aperture Radar
SARP	SAR Processor
SEMP	Source Encoder Multiplexer Packetizer
SEU	Single-Event Upset
SODR	Spaceflight Optical Disk Recorder
STP	Short-Term Plan
T	Tera - SI unit for 10E-12
Tbit	Terabit
TDRSS	Tracking and Data Relay Satellite System
TFG	Transfer Frame Generator
TX	Transmitter
VHSIC	Very High-Speed Integrated Circuit
VLSI	Very Large-Scale Integration
VMP	LaRC-developed VHSIC Multiprocessor system

APPENDIX B

REFERENCED DOCUMENTS AND STANDARDS

This appendix contains a list of standards referenced in this document, and other related documents that may be useful.

USEFUL DOCUMENTS AND STANDARDS

Document ID	Title
--	(Draft) Requirements for the Configurable High Rate Processor System CHRPS, 27 January 1989
DR NO: UID-101	EOS Platform General Instrument Interface Specification, 23 March 1990.
--	Office of Aeronautics, Exploration, and Technology Civil Space Technology Initiative High Rate/Capacity Data Systems Program Plan, Revised July 1991
CCSDS 701.0-B-1	Advanced Orbiting Systems Networks and Datalinks: Architectural Specification Blue Book, October 1989
CCSDS 102-B.2	Packet Telemetry
MIL-STD-1553B	Military Standard Aircraft Internal Time Division Command/Response Multiplex Data Bus
NTIS: 91 N 17277	R. Mielko, Old Dominion University, Norfolk Virginia, Algorithm to Architecture Mapping Model Multicomputer Operating System Functional Specification
MIL-STD-883C	Test Methods and Procedures for Microelectronics
ANSI/MIL-STD-1815A	Reference Manual for the Ada Programming Language
MIL-STD-1750A	16-Bit Computer Instruction Set Architecture
MIL-STD-490A	Specification Practices

APPENDIX C

TEST MATRIX

This appendix lists the ETB Performance requirements and indicates the method of performance verification. A short description of the requirement is stated for reference along with the paragraph number containing that requirement.

The method of verification is defined as follows:

I – Inspection
A – Analysis
T – Test
D – Demonstration
N/A – Not Applicable

MIL-STD-490 defines the methods.

Table C-1
Verification Cross Reference

Method (I A T D)	Paragraph No.	Brief Description of Requirement
N/A	3.0	PERFORMANCE REQUIREMENTS OF THE ETB
N/A	3.1	HIGH RATE NETWORK GENERAL REQUIREMENTS
T	3.1	Error rate better than 10E-12
T	3.1	Distance of 50 meters
N/A	3.2	OPTICAL SWITCH
I	3.2	Optical crossbar (nonblocking)
D	3.2	High speed data paths
I	3.2	32 I/O ports
T	3.2	Receive commands over low rate
T	3.2	Establishes connections between any combination of ports
T	3.2	Broadcast data
T	3.2	Reconfigured in under 50 ms
T	3.2	Simultaneous transmissions
T	3.2	Rate of 1 Gbps
T	3.2	Throughput of 800 Mb/s (TBR) per path
N/A	3.3	HIGH RATE INTERFACE
T	3.3	Connect user EDM to data path
D	3.3	Supports lower data rates
T	3.3	Insensitive to data patterns
T	3.3	Packets up to 882 (TBR)
N/A	3.4	SYSTEM CONTROLLER
I	3.4	CSCA is in network computer
I	3.4	1750A
I	3.4	Ada
D	3.4	Receive STP via simulated bus
D	3.4/3.8	Test bed simulates spacecraft link
D	3.4	STP contains data fields
T	3.4	Time-tagged commands loaded
N/A	3.5	LOW RATE NETWORK
I	3.5	There is low rate network
A	3.5	Supports 31 nodes
I	3.5	1553B
N/A	3.6	LAN GATEWAY
I	3.6	Lan gateway exists
D	3.6	Transfers STP
N/A	3.7	TDRSS GATEWAY
I	3.7	TDRSS gateway exists

Table C-1 (Continued)

Method	Paragraph No.	Brief description of requirement
I A T D		
I	3.7	4 input ports
T	3.7	Variable rates
I	3.7	5 output lines
T	3.7	Fixed rates
T	3.7	Aggregate 300 Mbps
I	3.7	Connects to HRIF and TFG
T	3.7	Proper format including fill
N/A	3.8	PERFORMANCE TESTING AND VALIDATION RESOURCES
T	3.8	Measures BER with BERT
T	3.8	Measures bus traffic
T	3.8	Measures data rates
I	3.8	Assist verification of operation
T	3.8	Verify data sent/received
T	3.8/3.4	Test bed simulates spacecraft link
T	3.8	STP transferred via gateway and low rate network
I	3.8	Assist in automating testing
I	3.8	Maintains status displays
T	3.8	Displays active connections
T	3.8	Displays volume of data
T	3.8	Displays error rates
T	3.8	Displays commands being executed
T	3.8	Displays are automatic
I	3.8	Adapter to BERT exists